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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/729,833	12/06/2000	Pei-Ren Jeng	4425-090	5660

7590 02/18/2003

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EXAMINER

LEE, HSIEN MING

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 02/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/729,833

Applicant(s)

PEI-REN JENG

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 January 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 51-63 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 51-63 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

1. Applicant's request for RCE is acknowledged.
2. Claims 51-63 are pending in the application.
3. The 112-second-paragraph rejection to claims 51, 53 and 54 and objection to claims 55, 58 and 60 are withdrawn in response to applicant's amendment filed 10/17/02.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claim 62 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 62 recites the limitation "the etching selectivity" in line 1. There is insufficient antecedent basis for this limitation in the claim. The base claim 51 does recite "an etching rate" at line 8, but not "etching selectivity."

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

7. Claim 51 is rejected under 35 U.S.C. 102(e) as being anticipated by Chen et al. (US 6,080,663).

Chen et al. expressly teach the claimed method for forming a dual damascene opening, comprising:

- providing a substrate 200 with a dielectric layer 204 in a thickness thereon (Fig.2A);
- providing a first patterned photoresist layer 208 on said dielectric layer 204 to expose a portion of said dielectric layer 204 at which at least a portion of a trench is to be formed (Fig.2B);
- implanting ions 210 into said exposed dielectric layer 204 in a depth h of part of the thickness under the masking of said first patterned photoresist 208 so as to form a dense (doped) region 212 having an etch rate lower than that of said dielectric layer 204 (Fig.2B);
- removing said first patterned photoresist layer 208 (Fig.2C);
- providing a second patterned photoresist layer 218 on said dielectric layer 204, said second patterned photoresist 218 defining an etching opening 217a for exposing at least part of said dense region 212 (Fig. 2C) and a region of said dielectric layer 204 in which a via hole 220b is to be formed (Fig.2D);
- etching said exposed dielectric layer 204 and said dense region 212 simultaneously under the masking of said second patterned photoresist 218 until a portion of said substrate 200 is exposed (Fig. 2D); and
- removing said second patterned photoresist layer 218 (Figs. 2D-2E).

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8. Claims 51 and 63 are rejected under 35 U.S.C. 102(e) as being anticipated by Jeng (US 6,372,660).

Jeng expressly teaches the claimed method for forming a dual damascene opening, comprising:

- providing a substrate 500 with a dielectric layer 510 in a thickness thereon (Fig.5A);
- providing a first patterned photoresist layer 520 on said dielectric layer 510 to expose a portion of said dielectric layer 510 at which at least a portion of a trench is to be formed (Fig.5A);
- implanting ions 530 into said exposed dielectric layer 510 in a depth of part of the thickness under the masking of said first patterned photoresist 520 so as to form a dense region 540 having an etch rate lower than that of said dielectric layer 510 (Fig.5A);
- removing said first patterned photoresist layer 520 (Fig.5B);
- providing a second patterned photoresist layer 570 on said dielectric layer 510, said second patterned photoresist 570 defining an opening for exposing at least part of said dense region 540 and a region of said dielectric layer 510 in which a via hole 590 is to be formed (Fig. 5B);
- etching said exposed dielectric layer 510 and said dense region 540 simultaneously under the masking of said second patterned photoresist 570 until a portion of said substrate 500 is exposed (Fig. 5C); and
- removing said second patterned photoresist layers 570 (Fig.5C);

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wherein the method further comprises forming a hard mask layer 560 on said dielectric layer 510 (Fig. 5B).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claim 52 is rejected under 35 U.S.C. 103(a) as obvious over Jeng (US '660) in view of Muller (US 6,207,517).

Jeng substantially teaches the claimed method as stated above and further suggests that the implanting step 530 for forming said dense region 540, which is similar to the implanting step 430, can be performed a number of times using dopants such as P, As or BF₂ ions, whose dosage is about between 10¹² and 10¹⁵ with energy about between 20 KeV and 100 KeV (col. 5, lines 16-22). In contrast, Jeng does not expressly teach that the multiple implantations are a retrograde implantation.

Muller, however, in an analogous art of forming a dense region in a dielectric layer teaches: providing a substrate 10 (Fig. 1a); forming the dielectric layer 20 on the substrate 19 (Fig. 1a); providing a first photoresist layer 30 on the dielectric layer 20 (Fig. 1b); implanting ions I by using the first photoresist layer 30 as a mask to form the dense (implanted) region 40 (Fig. 1b); and removing the first photoresist layer 30 (Fig. 1c; col. 4, lines 62-63); in which a multiple implantation process is used in the method including three ion implantation steps I1, I2

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and I3 into the dielectric layer 20 with gradually increasing implantation concentration profile (col.5, lines 23-28) as shown in Fig. 2 . The dopant used in the multiple implantation process would include a P or B ion (col.2, lines 40-44). The multiple implantation process of Muller is a retrograde implantation process (col. 6, lines 33-34).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize the retrograde implantation of Muller in the implanting step of Jeng for forming the dense region since by doing so it would be able to weaken bond structure, which is beneficial to subsequently etching the dense region (col.5, lines 7-11, Muller).

11. Claims 53-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jeng (US '660) and Muller (US '517) as applied to claims 51-52 above and further in view of Wu (US 6,127,247).

In re claims 53-61, Jeng in view of Muller fails to teach that the retrograde implantation energy is 20~100 KeV for the first step, 350~700 KeV for the second step and 1~3 MeV for the third step; and that the implantation dosage is $10^{12} \sim 10^{15}$ atoms/cm².

Wu, however, in a retrograde implantation process teaches that the first, second and third energies are 100 ~ 1,000 KeV (col.4, lines 36-42), 500 KeV ~ 5MeV (col.5, lines 15-16) and 200 KeV ~ 3MeV (col. Lines 5, lines 24-25), respectively; and the first, second and third implantation doses are 10^{12} atoms/cm² ~ 10^{13} atoms/cm² (col.4, line42), 5×10^{11} atoms/cm² ~ 10^{15} atoms/cm² (col.5, lines 16-17) and 10^{12} atoms/cm² ~ 5×10^{13} atoms/cm² (col.5, lines 25-26), respectively.

Therefore, it would have been obvious to one of the ordinary skill in the art at the time the invention was made to utilize the specific energies and doses as taught by Wu in the

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retrograde implantation of Jeng in view of Muller since by doing it would eliminate additional masking layer for the implantation and avoid outgassing issue in the convention process (col.3, lines 1-3, Wu), which, in turn, would reduce manufacturing cost (col.2, lines 16-21, Wu).

In re claim 62, the selection of the etched selectivity between the dense region and the dielectric layer is obvious to one of the ordinary skill in the art because it is a matter of determining optimum process condition by routine experimentation to selectively etch the predetermined etched region without damaging rest portions of the dielectric layer. In this case, the originally filed specification fails to demonstrate the criticality as to why the etched selectivity has to be about 2 for achieving unexpected results. See M.P.E.P. 2144.05 III.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-305-0142 for regular communications and 703-305-0142 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.


Hsien Ming Lee
February 13, 2003